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ABSTRACT

The course of study represents the last of six modules in advanced crop and soil science and introduces the agriculture student to the topic of soil erosion. Upon completion of the two day lesson, the student will be able to: (1) define conservation, (2) understand how erosion takes place, and (3) list ways of controlling wind and water erosion. The course outline suggests teaching procedures, behavioral objectives, teaching aids and references, problems, a summary, and evaluation. A materials source list for the complete soil module is included. (MW)

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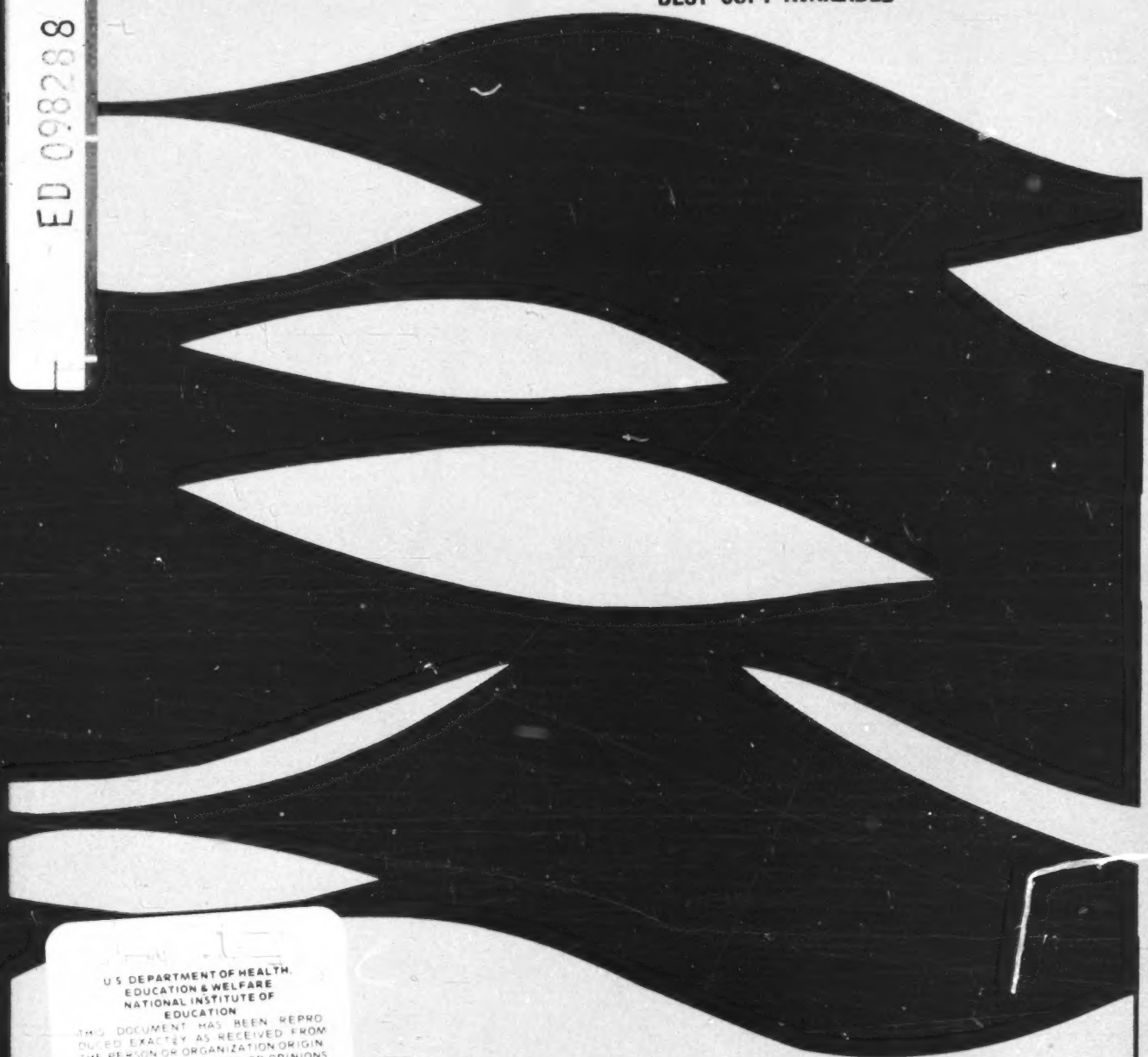

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SOIL EROSION

Agricultural Education, College of Education
Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

In Cooperation With

Agricultural Education Service, Division of Vocational Education
State Department of Education, Richmond, VA 23216
Prepared by Larry E. Miller

Publication AP-14
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ADVANCED CROP AND SOIL SCIENCE
A COURSE OF STUDY

Prepared by
Larry E. Miller

Agricultural Education Program
Division of Vocational and Technical Education
College of Education
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

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A Virginia Polytechnic Institute and State University
Extension Division
Education Field Service Publication

How to Use This Book

This course of study is divided into six modules, as enumerated in the index. Each lesson plan contains the title of the:

course,
module,
a suggested time allotment,
a suggested teaching procedure,
objectives of the lesson,
example introduction techniques,
suggested references and teaching aids,
problems,
summary,
and example evaluatory statements.

Space is provided for individual evaluation.

Modules are lettered consecutively, with numbered pages within each module. A small letter following the number denotes its position within the numbered sequence. Following the lesson plans, pages are also denoted with the letter "H", recommended as a handout; and the letter "T", recommended as an overhead transparency.

Some instructors may find it of greater convenience to assemble a "slide-bank" of these teaching aids.

Materials Source List
(Soil Module Only)

SELECTED REFERENCES:

Books:

*Profitable Soil Management, Knuti, Korpi and Hide, Prentice-Hall, Englewood Cliffs, New Jersey 07632, 1969, $8.36.

*Introductory Soils, Berger, K.C., 1965, Macmillan Company, 866 3rd. Avenue, New York, N.Y. 10022, $8.50.

*Soils: An Introduction to Soils and Plant Growth, 2nd Ed., Donahue, Prentice-Hall, 1964, $9.75.

*Approved Practices in Soil Conservation, Foster, Interstate, 1964, $3.80.

*Our Soils and Their Management, Donahue, Interstate, $5.00.

**Farm Soils, Worthen and Aldrich, Wiley & Sons.

**Fundamentals of Soil Science, Millar, Turk.

**The Nature and Properties of Soils, Buckman and Brady, Macmillan, 1969, $10.95.

**Soils and Soil Fertility, Thompson, McGraw-Hill.

**Soil Fertility and Fertilizers, Tisdale and Nelson, Macmillan, 2nd Ed. 1966, $12.95.

**Soil Use and Improvement, Stallings, J.H., Prentice-Hall, $8.36.

**Soil Management for Conservation and Production, Cook, J.W. Wiley and Sons, 1962.

**Soil Physics, Kohnke, McGraw-Hill.

**Using Commercial Fertilizers, McVicker, Interstate, 1961, $4.00 Good.

**Our Natural Resources, McNall, Interstate, 1964.

**Soil Science Simplified, Kohnke & Helmut, Bolt, 1962. Good.

**Soil Conservation, Stallings, Prentice-Hall, 1957, $11.75.

*Experiments in Soil Science, California State Polytechnic College, San Luis Obispo, California 93401, $4.00.

**Factors of Soil Formation, Jenny.

Bulletins:

*"Soil Judging in Indiana" Purdue Mimeo I.D. 72.

*"Soil Color" Voc. Ag. Service, 434 Mumford Hall, Urbana, Illinois 61801

*"Soil Texture" - Illinois V.A.S.

**"Teaching Soil and Water Conservation, A Classroom and Field Guide" PA 341 U.S.D.A.

**"Water Intake by Soil Experiements for High School Students" Misc. Publ. No. 925, U.S.D.A.

**Soils Yearbook, U.S.D.A.

**Land Capability Classification, Agriculture Handbook No. 210, U.S.D.A.

**Soil Survey Manual, U.S.D.A."

*"Sampling the Soil", National Fertilizer Association, Washington, D.C.

*"Soil Testing" Purdue University Extension Circular, 488.

**"The Fertilizer Handbook:, National Plant Food Institute (NPFI) 1700 K. Street N.W., Washington, D.C. 20006

*Student Reference

**Instructor or Classroom reference

*"Our Land and Its Care", N. P. F. I.
*"What is Fertilizer?" N. P. F. I.
*"How to Take a Soil Sample", N. P. F. I. (Leaflets** and Poster*)
*"Lime Means More Money for You", N. P. F. I. (leaflets** and Poster*)
**"How Soil pH Affects Plant Food Availability", N. P. F. I. (Poster)
**"Hunger Signs in Crops", Illinois V. A. S., VAS 4011a
*"Soil and Plant Tissue Tests", Purdue Station Bulletin 635
*"Soil Science Simplified", Kohnke, Published by Author

Films:

"The Depth of Our Roots", New Holland, C-18 Min.
"Making the Most of a Miracle" (Plant Nutrition), N. P. F. I.
"The Big Test" (Importance of Soil Testing), N. P. F. I.
"What's in the Bag" (Fertilizer) N. P. F. I.

Film Bulletin:

"Films to Tell the Soil and Water Conservation Story" 1970 Soil Conservation Service, Film Library, Rm. 503-134 So. 12th St., Lincoln, Nebraska 68508.

Film Strips:

"Soil Color" Vo-Ag. Service, 434 Mumford Hall, Urbana, Illinois.
"Soil Structure" Vo-Ag. Service, Illinois.
"How and Why Soils Differ", Vo-Ag. Service, Illinois.

Slides:

"How to Take a Soil Sample", N. P. F. I.
"Soils, Plant Nutrition and Fertilizers", N. P. F. I.
"Deficiency Symptoms" (Choice by crop, 25¢ ea.) N. P. F. I. (Send for Catalog.)
"Soil Profile Slides", 16 slides, $6.00. (Send for Catalog.)

Periodicals:

"Plant Food Review", N. P. F. I. (Free to Schools.)

TEACHER'S CURRICULUM GUIDES FOR SOILS

"Understanding the Nature and Importance of Soil", AP-1, C. E. Richard, VPI & SU, Blacksburg.

"Preparing the Soil for Planting", AP-3, C. E. Richard, VPI & SU, Blacksburg.

"Developing a Soil and Water Conservation Plan", AP-4, C. E. Richard, VPI & SU, Blacksburg.

"Testing Soils", AP-8, C. E. Richard, VPI & SU, Blacksburg.

"Determining Land Capability Classes", AP-2, C. E. Richard, VPI & SU, Blacksburg.

Extension Division Bulletins, VPI & SU,
Blacksburg, Virginia 24061.

NO.	PUBLICATION
342	"No-tillage Corn - Current Virginia Recommendations"
429	"Soil Fertility Guides for the Piedmont"
97	"Agronomy Handbook"
136	"How Soil Reaction Affects the Supply of Plant Nutrients"
297	"Soil Fertility Guides - for the Coastal Plains Region of Virginia"
299	"Soil Fertility Guides - for the Appalachian Region of Virginia"
684	"Liming for Efficient Crop Production"
36	"Your Fertilizer Use and Crop Record"
106	"Lime Use Guides - for the Coastal Plains Region of Virginia"
107	"Lime Use Guides - for the Appalachian Region of Virginia"
108	"Lime Use Guides - for the Piedmont Region of Virginia"
405	"Lime for Acid Soils"
34	"Soil and Water Conservation Record Book"
CS48	"Soil Sterilization"
47	"Know Your Soils, Unit 2, Major Soil Differences"
23	"The Story of Land"
228	"Working Together for a Liveable Land"

USDA Bulletins (1 each of 100 publications, free)
Publications Division, Office of Information,
U.S.D.A., Washington, D.C. 20250. *FOR SALE ONLY

NO.	PUBLICATION	PRICE
AH210	Land Capability Classification. 1961	.15¢
AH18	Soil Survey Manual. 1951.	$3.50*
AB320	Know the Soil You Build On. 1967.	--
L539	Land Forming, A Means of Controlling Surface Water on Level Fields. 1967	.05*
L512	Mulch Tillage in the Southeast	--
YB1957	Soil (Yearbook)	$4.00*
L307	How Much Fertilizer Shall I Use? 1963.	--
G89	Selecting Fertilizers for Lawns and Gardens. 1971.	--
TITLE	Superphosphate: Its History, Chemistry, and Manufacture. 1964.	$3.25*

*"Maintaining Organic Matter in Soils" VAS, Illinois
*"Soil Structure" VAS, Illinois

*Student Reference
**Instructor or Classroom Reference

TEACHING AIDS:

1. Samples of Soil separates, Purdue Agronomy Club
   Life Science Building
   Purdue University
   Lafayette, Indiana 47907

2. Soil Profiles
   Information and directions necessary to make soil profiles.

3. Land Capability Maps - Local S. C. S. Office.

4. Soil Auger: Nasco, price range $4.79 - $13.50.

5. Tissue Test Kit V. A. S. $4.00/kit.

6. Transparencies.

7. Samples of soil structure.

PREPARING FOR SOILS MODULE

Proper preparation, as in all things, is one of the best assurances of success. Therefore, it is imperative that prior planning be completed before teaching each lesson.

Plans should be made several weeks or months preceding the need for much of the material. Films should be booked as soon as possible to assure their arrival when needed. This will necessitate careful thought in the preparation of your teaching calendar for this module. An inventory of present equipment should yield information necessary to securing needed teaching aids, equipment, and replenishing supplies.

Many other teaching aids can be compiled on shorter notice. Handouts and overhead transparencies can be supplied on rather short notice in most schools. Adjustments will be necessary according to the instructor's and school's clerical assistance in this area.

Short range planning varies considerably with individual instructor's competencies in the teaching area and with previous teaching experience. One may generalize, however, and conclude from good teaching methods, that films should be previewed; experiments and demonstrations "pre-run". Subject matter should be reviewed, and adapted and updated lesson plans will be of benefit for each lesson.

The author has attempted to exclude materials that were presumably taught in previous vo-ag. offerings. It will be necessary for each instructor to discern if a review of previous material is necessary. The author has attempted to provide several teaching techniques for each lesson. It is not assumed that all would be used within the time allotment, but that you may have as many alternatives as possible from which to select.

Soil Module Time Allotment
Allotted days: 15 (at 55 minutes period per day)

Lesson		Minutes
I:	What is soil?	110
II:	Physical Features of Soil	110
III:	Biological Features of Soil	110
IV:	Soil Water	165
V:	Chemical Features of Soil	220
VI:	Soil Erosion	110
	TOTAL (15-55 min. days)	825

Course: Advanced Crop and Soil Science

Module: Soils

Lesson VI: Soil Erosion

Suggested teaching time: 2 days

Suggested teaching procedure:

1. Introduce lesson by relating objectives and motivational statements and/or using other teaching aids to stimulate interest.

2. Make assignment and supervise study period.

3. Discuss results using teaching aids:

   a) Show transparency "Conservation" and define conservation and discuss what happens when it rains.
   b) Show transparencies, "Effects of Erosion", "Estimated Annual Costs of Soil and Water Losses", "Factors Influencing Water Erosion", "Soil Water Erosion", "Wind Erosion", "Forces of Wind Erosion", "Controlling Water Erosion", and "Controlling Wind Erosion" to foster an awareness of the severity and consequences of erosion. Supplement with other teaching aids; field trips and guest speakers would be extremely helpful.

4. Summarize and evaluate lesson.

Objectives:

1. Students be able to define conservation.

2. Students understand how erosion takes place.

3. Students be able to list ways of controlling wind and water erosion.

Introduction:

It's estimated that every 10 seconds, the Mississippi carries 140 tons or 280,000 pounds of soil out to sea. What can be done to control this tremendous loss of our valuable soil?

References:

Text: Selected references, example: Approved Practices in Soil Conservation, Foster, Interstate, 1964

Bulletins: "Teaching Soil and Water Conservation, A Classroom and Field Guide", USDA
"Experiments in Soil Science", pp 63-75, V. E. P.
"Our Land and Its Care," N. P. F. I.

Film Bulletin: "Films to Tell the Soil and Water Conservation Story", S. C. S.

Problems:

1. What is conservation?
2. What happens to the soil and water when it rains?
3. What is the overall effect of erosion?
4. What does erosion cost the farmer?
5. What factors influence water erosion?
6. How does wind erode the soil?
7. How does water erode the soil?
8. How can you control water erosion?
9. How can you control wind erosion?
10. Is it economical to terrace land?

Summary:

Erosion is constantly robbing us of our valuable fertilizer, organic matter, and soil. The means we use to control this loss often seem expensive, but are inexpensive in the long run, as they increase the value of our land and prevent a tremendous loss.

Evaluation:

A. Have the students been able to achieve the lesson's objectives?

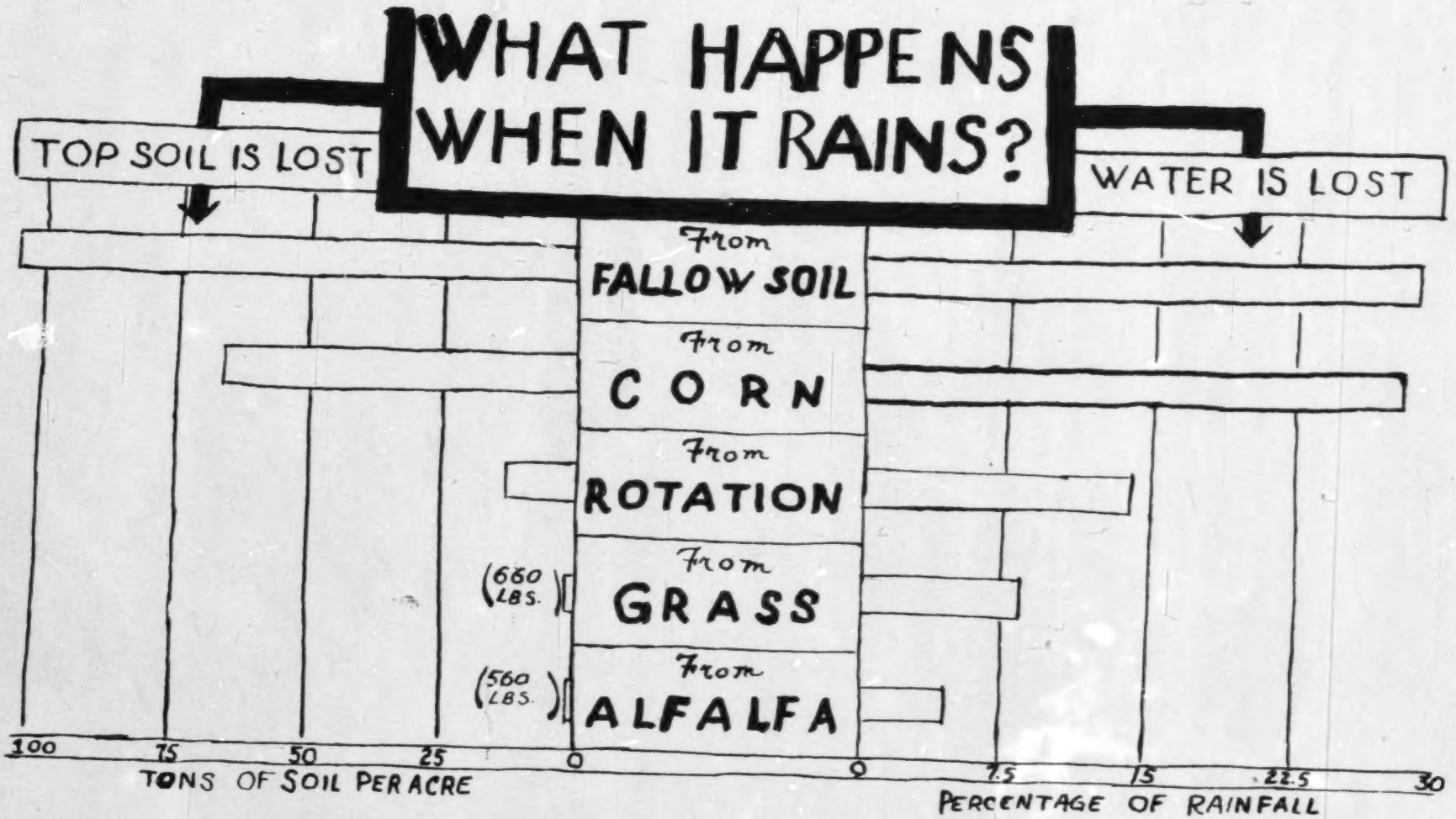
B. Do they realize the consequences of erosion?

C. Do they understand what measures can be taken to control erosion?

Student evaluation:

CONSERVATION:

MEANS "WISE USE"


WHAT HAPPENS WHEN IT RAINS?
TOP SOIL IS LOST
WATER IS LOST
From FALLOW SOIL
From CORN
From ROTATION
From GRASS
(660 LBS.)
From ALFALFA
(560 LBS.)
100
75
50
25
0
0
7.5
15
22.5
30
TONS OF SOIL PER ACRE
PERCENTAGE OF RAINFALL

EFFECTS OF EROSION

1. LOSS OF BEST PART OF THE SOIL.
2. REDUCED YIELDS.
3. INCREASED FERTILIZER REQUIREMENT.
4. PRODUCTION OF LOWER-INCOME CROPS.
5. FORMATION OF GULLYS.
6. COVERING OF RICH BOTTOMLANDS BY SOILS FROM POORER UPLANDS
7. DESTRUCTION OF ROADBANKS AND BRIDGES.
8. SILTING OF DAMS, LAKES, AND RESERVOIRS.
9. INCREASED FLOOD HAZARDS.
10. WASTE OF NEEDED WATER.

ESTIMATED ANNUAL COSTS OF SOIL AND WATER LOSSES
(1951 - 60)

KIND OF LOSS	AVE. ANNUAL LOSS ($1,000.)
ON CROPLAND:	
1. EROSION - WIND OR WATER	800,325
2. FLOODING OR HIGH WATER TABLE	291,000
3. DETERIORATION OF SOIL CONDITION	353,050
ON OTHER LANDS:	
4. EROSION - WIND OR WATER	166,500
FLOOD DAMAGE - UPSTREAM AND DOWNSTREAM AREAS:	
5. FLOODWATER, SEDIMENT, ETC.	1,345,454
WATER LOSSES:	
6. IRRIGATION	665,000
7. OTHER (EVAPOTRANSPIRATION)	204,000
TOTAL LOSSES	3,825,329
SPENT TO CONTROL LOSSES	238,080
GRAND TOTAL	4,063,409

FACTORS INFLUENCING WATER EROSION

1. COVER
2. SLOPE
   - A) PERCENT
   - B) LENGTH
   - C) UNIFORMITY
3. SOIL CONDITION
   - A) ORGANIC MATTER
   - B) STRUCTURE
4. RAINFALL
   - A) INTENSITY
   - B) DURATION
   - C) FREQUENCY OF OCCURANCE
   - D) SEASONAL DISTRIBUTION

SOIL WATER EROSION

1. SPLASH EROSION
   - A) DETACHES SOIL
   - B) DESTROYS GRANULATION
   - C) TRANSPORTS SOIL
2. SURFACE - FLOW, SHEET EROSION
   - A) SURFACE CREEP
   - B) SUSPENDED SOIL IN WATER
3. WATER FLOW - CONCENTRATED
   - A) RILL
   - B) GULLY

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GULLY EROSION

Gully erosion is the most noticeable type. Large volumes of soil are removed in a concentrated area. Gullies are what most people think of when they think of erosion. Gullies are usually found near the bottom of the slope. As a result of gullying, soil is lost, tile lines are washed out, fields are divided into two or more parts, and productive lowland soil is covered with sand, gravel, stones, or low-fertility subsoil from the slopes above.

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MODERATELY ERODED FIELD

This soil has been moderately eroded. In many areas, the dark-colored A_1 horizon has disappeared, exposing the light colored A_2 horizon. These lighter colored areas usually contain higher clay content and may cause increased problems in farming.

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SHEET EROSION

Soil damaged by water is often divided into two types - sheet and gully erosion. Sheet erosion consists of the removal of a thin, fairly uniform layer of soil from the surface of a field. Sheet erosion is actually more common than gully erosion. It is also more serious because it takes place so gradually that it is seldom recognized for what it is. It may be compared to tearing off sheets of paper from a note pad. Removal of one sheet is not particularly noticeable; but continued removal of successive sheets eventually reduces the thickness of the pad. Likewise, one rain may remove a thin layer of soil and the field will look much the same. This may continue for a considerable time, depending on the depth of the topsoil, and still the field will appear little changed. But as the topsoil gets thin, plants make poor growth and crop yields are much reduced. Gullies also begin to appear, and then the added losses of gully erosion are piled on those of sheet erosion.

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WATER EROSION

Every muddy creek or river shows that valuable soil is being carried away. About three-fourths of our soils are on slopes steep enough to cause water erosion. On many fields most or all of the original topsoil has been lost in this way.

Every time a hard rain hits unprotected land, more soil is washed away. An inch of rain falling on an acre of land contains enough energy, if we could use it, to plow 10 acres. Every raindrop falling on bare, wet soil is like the explosion of a tiny bomb. The force of the splash dislodges fine soil particles which clog the soil pores, reducing the soil's ability to absorb water. As a result, more water runs off the land. It is estimated that during a heavy storm as much as 100 tons of soil may be bouncing up and down on each acre. Not only is soil torn loose to be washed down the slope, but available plant food is dissolved and carried away also.

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GENERALIZED SOIL EROSION MAP OF THE UNITED STATES

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GENERALIZED SOIL EROSION MAP OF THE UNITED STATES

The United States has approximately two billion acres of land. Cropland makes up about 610 million acres of this total land area. The Soil Conservation Service has estimated that approximately 50 million acres have been ruined by erosion and another 50 million have been substantially damaged by erosion.

When a heavy rain erodes topsoil, the subsoil is closer to the surface. The subsoil may contain increased clay, less organic matter, decreased nutrients, droughty sandy material, worthless hardpan or even rock. Subsoil farming is usually a more unprofitable venture.

What is Erosion?

Erosion is the wearing away of the soil by forces of water and wind. Their action is different but the results are the same. They both remove surface soil from the land. Wind erosion, while not generally serious in Illinois, does injure relatively small areas of sandy land in several parts. Under certain conditions heavier soils may also be considerably damaged by wind. Water erosion is very serious in the state. Nature has provided protection for the soil in the forms of vegetative cover. Vegetation protects the soil by breaking the force of raindrops, and holding the soil together by the root system. Man, however, has upset the balance by removing vegetation and leaving the soil defenseless against the climatic forces of water and wind.

The transparency shows the relative importance of soil erosion for the United States. Level areas have little or no erosion while areas that are sloping or hilly suffer most from erosion. In areas that receive 30 inches or more of rainfall annually, most erosion is caused by water. When rainfall is less than 20 inches, wind becomes the major eroding force. Both wind and water will cause erosion where the rainfall is between 20 and 30 inches. When rainfall exceeds the rate at which soil can absorb the moisture, runoff and erosion will occur.

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SEVERELY ERODED FIELD

This is a severely eroded field in which all the topsoil has been lost from large areas, and the heavy clay subsoil is exposed. Note the gullies in the background. This can happen if you leave your soil unprotected on steep slopes.

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MAKE A CONSERVATION PLAN

Gullies can be treated and prevented. The sides of large gullies need to be seeded to vegetation, and the water diverted around the gully or spread out over a grassed waterway.

You should try to conserve your top soil. On moderate slopes, erosion can be controlled by growing crops on the contour, with rows level or nearly level from end to end. On longer slopes strip cropping is a more effective erosion-control measure than contouring alone. Strips of row crops, planted on the contour, can alternate with strips of close-growing crops as shown in this transparency. This will reduce erosion and provide a good cover. Terracing, however, is the most effective soil-conservation practice. Each terrace channel takes care of water between it and the terrace above. All tillage operations should be parallel to the terrace. Contack your local SCS office for assistance and help.

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WIND EROSION

3 TYPES

1. SALTATION - BOUNCES, ACT OF ESCAPING
2. SUSPENSION - IN AIR
3. SURFACE CREEP - GROUND SURFACE MOVEMENT

FORCES OF WIND EROSION

1. DETRUSION - PEAKS OR SURFACE PROJECTION GIVE UP COARSE GRAINS TO WIND.
2. EFFLUXIUS - .05 TO .5 MM BY DIRECT PRESSURE OF WIND
3. EXTRUSION - SURFACE CREEP OF PARTICLES TOO LARGE TO SALTATE
4. EFFLATION - FINE PARTICLES IN SUSPENSION
5. ABRASION - CHIPPING OFF PARTICLES

CONTROLLING WATER EROSION

1. CONTOUR FARMING - SURFACE-FLOW ONLY
2. STRIP FARMING - SURFACE-FLOW ONLY
3. TERRACES - SURFACE-FLOW ONLY
4. VEGETATIVE COVER

CONTROLLING WIND EROSION

1. DAMP SOIL
2. PLANT COVERS
3. WIND BREAKS
4. MOST WATER EROSION CONTROL METHODS
5. MULCH TILLAGE
6. RIDGING AT RIGHT ANGLES TO PREVAILING WIND

SOIL LOSS BY CROP UNDER VARIOUS CROPPING SYSTEMS

CROP	%SOIL LOSS*
CONTINUOUS CORN	100
ROW CROP AFTER ONE YEAR MEADOW	40
ROW CROP AFTER TWO MORE MORE YEARS MEADOW	35
ROW CROP AFTER SMALL GRAIN	90
THIRD YEAR ROW CROP AFTER ONE YEAR MEADOW	80
FOURTH YEAR ROW CROP AFTER ONE YEAR MEADOW	100
SPRING GRAIN AFTER ROW CROP AFTER ONE YEAR MEADOW	30
SPRING GRAIN AFTER THREE OR MORE YEARS ROW CROPS	40
SPRING GRAIN AFTER ONE YEAR MEADOW	15
SPRING GRAIN AFTER TWO YEARS MEADOW	10
MEADOW CROPS	1

*COMPARISON WITH CONTINUOUS CORN

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REDUCTION OF SOIL LOSS BY MANAGEMENT PRACTICES

PRACTICE	FACTOR
RESIDUES-PASTURE W/O GRAZING	.50
RESIDUES-PASTURE W/O MODERATE GRAZING	.75
RESIDUES-CROP RESIDUES REMAIN UNTIL PLANTED	.80
WINTER COVER CROP-PLOWED AT P PLANTING TIME	.80
MULCH-APPLIED AFTER PLANTING	.60
PLOW-PLANT - MINIMUM TILLAGE	.60

THIS ILLUSTRATES THAT PLOW-PLANTING WOULD REDUCE SOIL LOSS BY 60% OVER CONTINUOUS CORN.

IF YOU PLOW-PLANT AND USE A WINTER COVER CROP, SOIL LOSS REDUCTION WOULD BE:

.60 X .80 X 100 = 48% OF WHAT IT WOULD BE WITHOUT THE TWO PRACTICES.